Self-closing sheet for encapsulating and dumping a bulk of material

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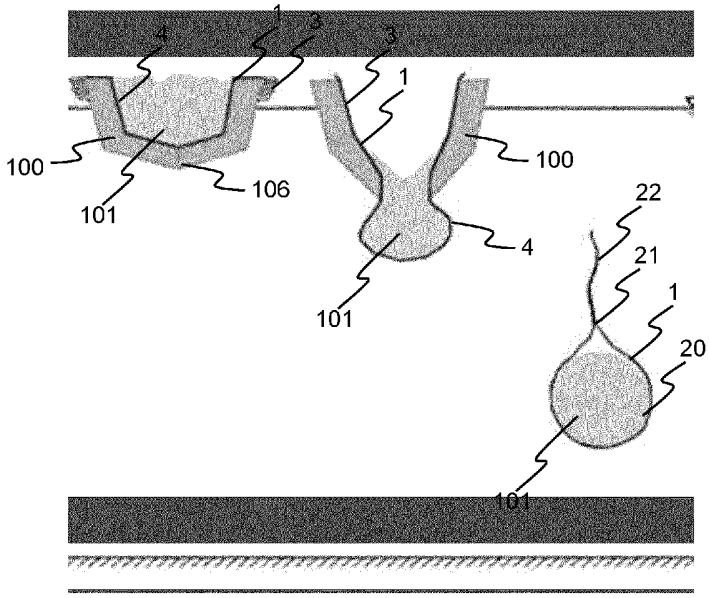

Fig. 1

(57) Abstract: The invention relates to a sheet (1) to be placed in relation to a split barge (100) for encapsulating a bulk of material (101) to be dumped when the bulk of material is released, the sheet comprising a material containing portion (4) and at least one material free portion (3) extending from at least two opposed sides of the material containing portion, wherein that the immersed sheet encapsulating the bulk of material comprises an encapsulated body (20) encapsulated by the material containing (4) portion and a self-closing portion (22) being at least a part of the material free portion (3) both extending from an assembly point (21), wherein a closing length of the self-closing portion (22) correspond to at least 5% of the circumventing length of the encapsulated body (20), the circumventing length extending from the assembly point (21) to the assembly point (21). The invention further relates to a method of encapsulating a bulk of material by means of a sheet.

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Self-closing sheet for encapsulating and dumping a bulk of material

FIELD OF THE INVENTION

The invention relates to a sheet to be placed in relation to a split barge for encapsulating a bulk of material to be dumped when the bulk of material is released, the sheet comprising a material containing portion and a material free portion extending from at least two opposed sides of the material containing portion. The invention further relates to a method of encapsulating a bulk of material by means of a sheet.

BACKGROUND OF THE INVENTION

Dredging - the excavation of materials such as sediment of soil, sand, clay, slit and/or rocks from beneath bodies of water such as rivers and oceans - is a large global industry that makes marine construction projects possible, and supplies a large portion of the world's sand consumption.

The industry reuses a large portion of the 9 billion cubic meter of matter it excavates every year for construction purposes, coastal feeding or landfilling. However not all material is suitable. Somewhere between 22-25% of the annual dredged volume comprises dredge spoils and fine sediments which requires disposal, as its small grain size makes it unusable for practical uses. The fine sediment is therefore instead dumped offshore where it may disturb the aquatic ecosystems, often with adverse long term effects, as the dumped sediment can remain in the water column for up to half a year where it may kill small organisms and in some cases cause deoxygenation.

Due to the potential hazards of oceanic dumping, the dredging industry is being met with increasingly high dumping costs, both through rising environmental fees and though the increased difficulty in finding suitable

dumping sites close to excavation sites. Initiatives have therefore been taken towards minimizing the sediment pollution caused by dumping. WO10116013 disclose e.g. a hopper barge containing a geotextile insulating bag containing a bulk of material that in some degree prevents dispersion of material when dumped. But as the geotextile bag does not encapsulate the material some sediment pollution may still take place.

Alternatively WO9729247 discloses an example of known flexible containers consisting of a textile fabric for receiving loose or lightly cohesive material via a closeable filling opening in order to form a bulk for deposition at a selected place, wherein the flexible container is sealed before dumping the bulk. A disadvantage of the known operations for sealing the flexible containers is that they are rather time-consuming.

Developers and contractors who hire dredging companies on the other hand, are encountering higher raw material costs, as the price of raw materials such as rocks, gravel and sand is rising due to demand and depletion of these resources in certain regions. At the same time, dredging companies are dumping in excess of 2 billion cubic meter of sediment annually, often close to construction sites.

It is therefore desirable to prevent dumped sediment from spreading throughout the water column in an easy and cost effective way and hereby reduce the strain on the already burdened global marine environment. Furthermore it is desirable to provide a way of increasing the utilization of dredged material by connecting the disjoint markets; dredging disposal and construction resources.

SUMMARY OF THE INVENTION

Disclosed herein is a sheet being placeable in relation to a split barge and configured for encapsulating a bulk of material to be dumped when the bulk of material is released, the sheet comprising a material containing portion and at least one material free portion extending from at least two opposed sides of the material containing portion, wherein the immersed sheet encapsulates the bulk of material and comprises an encapsulated body encapsulated by the material containing portion and a self-closing portion being at least a part of the material free portion both extending from an assembly point, wherein a closing length of the self-closing portion correspond to at least 5% of the circumventing length of the encapsulated body, the circumventing length extending from the assembly point to the assembly point.

The sheet may be configured for being released from the split barge before the sheet encapsulates the bulk of material, such that the sheet when being immersed comprises the encapsulated body encapsulated by the material containing portion and the self-closing portion wherein the self-closing portion may at least be a part of the material free portion.

The circumventing length may be defined as the length of the sheet from assembly point to assembly point when the sheet circumvents the body to be encapsulated.

The self-closing portion may at least be a part of a closing length extending from an assembly point towards a free end of the sheet. The free end of the sheet may be a free edge of the material free portion.

The closing length of the self-closing portion may be between 5%, i.e. one twentieth, and the double of the circumventing length of the encapsulated body, more preferably may the closing length be between one fourth and one and a half of the circumventing length of the encapsulated body.

The sheet may hereby be configured for being released from the split barge before the sheet encapsulates the bulk of material and/or without pre-closing and/or pre-sealing the sheet. This may eliminate the need of handling of the sheet after the sheet has been arranged on the split barge.

The material containing portion of the sheet may be arranged so that the material containing portion adjoins an inside or an outside surface of the split barge, i.e. an outside surface of the material containing portion may be arranged so that the material containing portion adjoins an inside surface of the split barge or an inside surface of the material containing portion may be arranged so that the material containing portion adjoins an outside surface of the split barge.

The material containing portion and the sheet in its entirety may comprise a centreline configured for being arranged along a centreline in the bottom of the split barge. The centreline of the split barge may be parallel to the sides, i.e. port and starboard, of the split barge and be placed mid between the two sides. The centreline of the material containing portion and the sheet in its entirety may divide the material containing portion and the sheet into the two opposite sides. The sheet may furthermore comprise another centreline perpendicular to above defined centreline also dividing the sheet into two opposite portions.

The material containing portion may be sized after the split barge the sheet is to be arranged in or on. The material containing portion may furthermore be formed into a bag or the like fitting into the split barge the sheets is to be arranged in or on.

In an embodiment the material free portion may comprise at least two material free portions extending from at least two opposed sides of the

material containing portion, whereas the opposite sides each extends from one of the centrelines of the sheet. The two material free portions may extend from the sides of the material containing portion arranged along the sides, i.e. port and starboard, of the split barge. The material free portion on each of the opposite sides of the material containing portion may extend or may be arranged to extend approximate with the same length from the material containing portion. The material free portion on each of the opposite sides of the material containing portion may extend or may be arranged to extend with different lengths from the material containing portion.

Alternatively the at least one material free portion may comprise one material free portion extending from the entire circumference of the edge of the material containing portion wherein at least two opposite sides of the material free portion approximate may extend or may be arranged to extend approximate with the same length from the material containing portion.

The material free portions may extend along an entire side of the material containing portion and/or along part of a side of the material containing portion. The material free portion may be an edge portion of the material containing portion or an added edge portion attached to the material containing portion.

As the bulk of material is released form the split barge and the weight of the bulk of material starts sinking the sheet towards the seabed, the sheet may be a self-closing sheet in the sense that the material containing portion of the sheet is urged around the bulk of material forming an encapsulated body and a tale, i.e. the self-closing portion comprising adjoining material free portions extending from at least opposite sides of the material containing portion. This may be achieved by the water pressure induced around the sinking sheet without applying any other means for closing and/or sealing the sheet. The assembly point between the encapsulated body and the self-closing portion

may likewise be formed during sinking of the sheet encapsulating the bulk of material.

The circumventing length of the encapsulated body may be defined as the length from where one side of the sheet meets the opposite side of the sheet in the assembly point.

The self-closing portion may at least comprise the one or more material free portions or a part of the one or more material free portions. The self-closing portion may extend from the assembly point and towards the water surface.

The advantage of enclosing the bulk of material is that the spread of the material in the water column between the water surface and the seabed or the bottom of a lake, river or the like is prevented when dumping the material.

The self-closing principle is possible due to the pressure field induced around the sinking sheet making the material free portions of the sheet adjoin. This as the pressure field sucks out water from within the sheet and thereby almost instantaneously urges the material free portions of the sheet towards each other. When the encapsulated body reaches the seabed, the sheet may remain closed, be partially open or open fully, in which case the sediment may be allowed to spread across the seabed.

The material to be dumped may be a substantially loose, suspendable and/or cohesive material e.g. sediment of soil, sand, clay, slit, rocks or other ground material.

By split barge is meant any barge, ship or vessel configured for dumping a bulk of material by splitting the hull or opening a bottom part such as one or more gates or flaps arranged in the hull of the barge, ship, vessel or the like.

The split barge may comprise more than one compartment, wherein each compartment is configured to hold a sheet.

A support element may be arranged on the split barge for supporting the material free portion of the sheet when the sheet is arranged on the split barge and during the filling of the split barge with material. The support element may be one or more racks arranged along the edge of the split barge. The support element may be configured for holding the material free portion of the sheet on the outside or inside surface of the split barge.

In one or more embodiments the sheet further comprises a mechanical and/or chemical sealing. The mechanical and/or chemical sealing may be added to the sheet for self-sealing the sheet concurrently with self-closing the sheet.

The mechanical and/or chemical sealing may be added to the sheet for being able to control when the sediment may be allowed to spread across the seabed. Alternatively the mechanical and/or chemical sealing may be added to the sheet if the encapsulated material is to be used as temporary building blocks. The sheet may be suitable for any shape including both approximately quadratic and approximately rectangular building blocks. The building blocks may advantageously be dumped at a construction site for re-bunding close to the dredging site.

The mechanical and/or chemical sealing may be arranged at least in the self-closing portion of the sheet and at least on the inside surface of the sheet. This as it is the inside surface of the self-closing portions which adjoins during sinking of the sheet encapsulating the bulk of material.

Alternatively the mechanical and/or chemical sealing may both be attached on the inside surface and the outside surface of the sheet. The mechanical

and/or chemical sealing may be attached on the outside surface of the sheet in one or both of the opposite sides of the sheet. This may allow that the bulk of material may be encapsulated by the sheet and sealed before releasing the sheet encapsulating the bulk of material from the split barge.

The mechanical and/or chemical sealing may thereby be configured for being engaged either before or after opening the split barge.

In one or more embodiments the mechanical sealing comprises a hook and loop fastener or a mushroom fastener. The hook and loop fastener may be known as Velcro®. The mushroom fastener may e.g. be a mushroom hook fastener known as Pressotex®. The hook and loop fastener or mushroom fastener may at least be attached on the inside surface of the self-closing portion of the sheet. The hook and loop fastener or mushroom fastener may additionally be attached on the outside surface of the sheet in one or both of the opposite sides of the sheet.

Alternatively the mechanical sealing may comprise at least one retaining barb arranged on a strap wherein the strap may be attached to the split barge. The strap may tightened around the self-closing portion of the sheet and engage the barb as the encapsulated bulk of material sinks. The strap may break or snap-off in a weak link or the like as the strap is fully outstretched between the split barge and the sinking encapsulated bulk of material.

In one or more embodiments the chemical sealing comprises an adhesive. The chemical sealing may be a mushroom fastener with an adhesive known as Duotec®. The adhesive may be applied at least to the inside surface of the self-closing portion of the sheet. The adhesive may additionally be applied on the outside surface of the sheet in one or both of the opposite sides of the sheet.

In one or more embodiments the sheet further comprises at least one mounting element for attaching the sheet to the split barge wherein the mounting element is configured for disengaging upon the weight of the sinking sheet encapsulating the bulk of material.

The sheet may be mounted to the split barge by means of a mounting and release system for mounting and releasing the sheet to/from the split barge. The mounting and release system may comprise a corresponding mounting element, wherein the mounting element is disengaged from the corresponding mounting element upon the weight of the sinking sheet encapsulating the bulk of material.

The mounting element may be any element on or in the sheet suitable for being used for unfolding the sheet and arranging the sheet on the split barge and/or to attach the sheet directly or indirectly to the split barge. The mounting element may be used for attaching the edge of the sheet to an upper edge or the side of the split barge.

The sheet may be released from the split barge after the split barge opens and when the sheet is fully outstretch from a centre line or a centre point of the sheet to the edge of the sheet as the weight of the material on the sheet pushing the sheet into the water. This may be an advantages as the mounting of the edge of the sheet may facilitate that the sheet is fully outstretch when it enters the water so that the formation of an assembly point and self-closing portion may become more efficient. Furthermore this may together with the self-closing concept render the dumping of encapsulated material quick and easy without the need for any manpower for pre-closing and/or pre-sealing the sheet.

In one or more embodiments the mounting element comprises a strap and a snap-off element. The corresponding mounting element may be a hook

attached directly or indirectly to the split barge. The hook may be a conventional open and/or closed load bearing hook.

In one or more embodiments the snap-off element comprises a weak link along the strap configured for being broken. The weak link may be broken by the weight of the sinking sheet encapsulating the bulk of material.

In one or more embodiments the snap-off element comprises a snap-off button. The snap-off button may be placed along the length of the strap so that the strap is split into two portions when the snap-off button is disengaged. Or the snap-off button may be placed in one of the ends of the strap.

It may be obvious for a skilled person that the mechanical and/or chemical sealing additionally may be used as a mounting element and that the mounting element additionally may be used as a mechanical and/or chemical sealing.

In one or more embodiments the mounting element and/or the mechanical sealing comprises a magnet.

One or more magnetic tapes and/or a plurality of magnets may be attached on or in the self-closing portion of the sheet. The magnets may be suitable for releasably attaching the sheet to the split barge as the split barge may be made of steel, whereas the magnets preferably is arranged at least in the edge of the sheet. The magnets may alternatively or concurrently be suitable for obtaining a self-sealing of the self-closing portion of the sheet whereas the magnets either may be arranged in the edge portion and/or so that they substantially covers the self-closing portion of sheet. The magnets may be suitable for sealing the sheet both before and after opening the split barge.

Alternatively the mounting element may comprise a strap without a snap-off element and a rope may comprise a snap-hook with a release mechanism, whereas the snap-hook may be fixed in on end to the rope and releasably attached to the strap in the other end. The release mechanism may be tricked by a pull with a certain weight corresponding to the weight of the sinking sheet encapsulating the bulk of material.

In one or more embodiments the sheet is made of a degradable material. The choice of type of degradable material may be based on when the bulk of material may be allowed to spread along the seabed.

The degradable material may be a biodegradable material. The biodegradable material may be a fiber based geotextile. The fiber based geotextile may be made from coconut fibers or jute. A geotextile made from coconut fibers or jute may be ideal for a completely degradable sheet. The geotextile may be surface treated in a water soluble biopolymer, ensuring that the geotextile degrades after a few years.

In one or more embodiments the sheet is made of a permanent material. The permanent material may be used if the encapsulated material is to be used as building blocks. The permanent material may be polypropylene and/or polyacetate.

The sheet may be made from the permanent material when the encapsulated bulk of material is used as building blocks e.g. for the use as the core or base of a dam, a quay, a bank reinforcement, a jetty or a breakwater, for filling holes or trenches in the bed of a waterway or the like.

In one or more embodiments the self-closing portion of the sheet is made from a different material than the remaining sheet. The material used for the self-closing portion my have a lower strength than the material used for the

remaining sheet, whereas the remaining sheet includes at least the material containing portion of the sheet.

In one or more embodiments the sheet may comprise an outer sheet configured for being attached to the split barge such that the sheet, as described above, constitute an inner sheet configured for being in contact with the bulk of material.

The outer sheet may be configured for being in direct contact with the split barge on one side and the inner sheet on the other side and the inner sheet may be configured for being in direct contact with the outer sheet on one side and the bulge of material on the other side. I.e. the inner and outer sheet may be arranged along an inside surface of the split barge. The surface of the inner sheet being configured for being in contact with the outer sheet may comprise a low friction surface, i.e. be slibbery.

The outer sheet may be attached to the split barge along an edge or part of an edge of the outer sheet by means of one or more wires attached to the split barge in one end and to the outer sheet in the other end. The wire(s) may be hooked to the split barge and/or to the outer sheet.

When using a sheet comprising the inner sheet and the outer sheet the bulge of material may be placed on/upon both the inner and the outer sheet in direct contact with the inner sheet. As the split barge is opened, the bulge of material starts to settle into the water beneath the split barge. At some point, determined by the length of the one or more wire(s), the wire(s) is tightened, causing the inner sheet to slide off the outer sheet. The inner sheet continues sinking towards the sea bed while the outer sheet will hang in the wire(s) and may be pulled back up into the split barge.

The material containing portion of the inner sheet may be configured for being folded, for example zig-zag folded, when being placed in the split barge. Folding parts of the inner sheet arranged along the inside surface of the split barge, may facilitate a degree of extendibility of the inner sheet. The provided excess material of the inner sheet may unfold during immersion of the bulge of material. The unfolded excess material of the inner sheet may provide an extendibility of the self closing portion of the inner sheet.

The outer sheet may be configured to withstand the peak forces in/on the sheet occurring when the bulge of material squeezes through the split barge when being opened. The outer sheet may be configured to protect the inner sheet from being teared up by sharp or rough surfaces and/or edges or other irregularities in/on the split barge. The outer sheet may be a TenCate® sheet or the like. The inner sheet may be configured to withstand the forces imposed on the sheet during descent toward the sea bed. The inner sheet may thereby be made of a material having a lower strength than when only using one sheet.

The cost of manufacturing the sheet is related to the requirements on the material strength. The advantage of using a sheet comprising the inner sheet and the outer sheet is that the inner sheet, which may be configured for single use, may require a relative low material strength and thereby have a relative low manufacturing cost. The outer sheet requiring a higher material strength and thereby a higher manufacturing cost may be reusable.

Further disclosed herein is a method of encapsulating a bulk of material by means of a sheet as described above, the method comprising; arranging the sheet in or under the split barge, filling the sheet or the split barge with the bulk of material, opening the split barge so that the weight of the bulk of material starts sinking the sheet towards the seabed, encapsulating the bulk of material followed by leading the sheet into an assembly point by means of

the water pressure induced around the sinking sheet, and engaging the self-closing of the self-closing portion.

The step of opening the split barge may hereby be done before the sheet may be closed around the bulk of material and optionally sealed.

If the sheet is mounted to the split barge with the mounting element, the step of disengaging the mounting element may be done between the steps of opening the split barge and encapsulating the bulk of material.

In one or more embodiments, wherein the sheet comprises the mechanical and/or chemical sealing, the method further comprises engaging the mechanical and/or chemical sealing concurrently with engaging the self-closing of the self-closing portion.

In one or more embodiments, wherein the sheet comprises the outer sheet such that the sheet, as described above, constitute an inner sheet, the method further comprises retrieving the outer sheet to the split barge.

The outer sheet may be attached to the split barge along an edge or part of an edge of the outer sheet by means of one or more wires attached to the split barge in one end and to the outer sheet in the other end. The wire(s) may be hooked to the split barge and/or to the outer sheet.

The outer sheet may be retrieved by pulling the outer sheet back into the split barge. The outer sheet may be retrieved to or pulled back into the split barge before closing the split barge.

Further disclosed herein is a method of encapsulating a bulk of material by means of a sheet as described above, the method comprising; arranging the sheet in the split barge, filling the sheet with the bulk of material,

encapsulating the bulk of material, engaging the mechanical and/or chemical sealing, and opening the split barge releasing the encapsulated bulk of material which sinks towards the seabed.

If the sheet is mounted to the split barge with the mounting element, the step of disengaging the mounting element may be done between the steps of filling the sheet and encapsulating the bulk of material.

This method may be particular useful when dumping on very low depths where the self-closing effect may not have the right conditions for working properly.

In one or more embodiments, wherein the sheet comprises the outer sheet such that the sheet, as described above, constitute an inner sheet, the method further comprises retrieving the outer sheet to the split barge.

The outer sheet may be attached to the split barge along an edge or part of an edge of the outer sheet by means of one or more wires attached to the split barge in one end and to the outer sheet in the other end. The wire(s) may be hooked to the split barge and/or to the outer sheet.

The outer sheet may be retrieved by pulling the outer sheet back into the split barge. The outer sheet may be retrieved to or pulled back into the split barge before closing the split barge.

BRIEF DESCRIPTION OF THE DRAWINGS

Different embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings, as follows;

Fig. 1 schematically shows a cross-sectional view of a sheet according to the invention with a self-closing portion and working by the self-closing concept;

Fig. 2 schematically shows a cross-sectional view of a sheet according to the invention arranged on a split barge;

Figs. 3A and 3B schematically show the disengagement of the sheet from the split barge according to the invention, and

Fig. 4 schematically shows the use of different embodiments for sealing the sheet according to the invention.

Fig. 5 schematically shows a cross-sectional view of a sheet according to the invention comprising an inner sheet and an outer sheet.

DESCRIPTION OF PREFERED EMBODIMENTS

Fig. 1 schematically shows a sheet 1 according to the invention with a self-closing portion 22 and working by a self-closing concept, whereas the self-closing concept works as following:

First the sheet 1 is arranged on or in a split barge 100 and a material containing portion 4 of sheet is filled with a bulk of material 101. A centreline of the sheet may approximately follow a centreline 106 of the split barge. A material free portion 3 of the sheet is hold along the edge of the split barge by a support element (not shown). In the presently illustrated embodiment and as shown in Fig. 2 the material containing portion of the sheet is arranged along an inside surface 103 of the split barge and the material free portion is hold by a support element 102 along an outside surface 104 of the split barge. Alternatively the sheet may be arranged along an outside surface of the split barge. The material free portion 3 may be zig-zag folded.

Then the split barge 100 is opened and the weight of the bulk of material 101 pushes the sheet 1 into the water. As the sheet and bulk of material sinks towards the seabed the water pressure around the sheet encapsulates the bulk of material forms an encapsulated body 20 and collects the material free portion 3 into a tale following the sinking encapsulated bulk of material. In the presently illustrated embodiment the tale starts at an assembly point 21 and extends toward the water surface, whereas the tale constitutes a self-closing portion 22 extending from the assembly point an away from the encapsulated body.

As the encapsulated body 20 may shift into different forms during immersion the assembly point may shift and a closing length of the self-closing portion may vary during immersion. Furthermore may the closing length, i.e. the length of the self-closing portion from the assembly point to the edge of at least one of the opposite sides of the sheet, and hereby the formation of the assembly point of at least two opposite sides of the sheet likewise depend on the density of the bulk of material as well as the volume of the bulk of material, as the split barge may not be properly filled or even only half filled when the split barge is opened and the bulk of material is released entailing a longer closing length.

Figs. 3A and 3B schematically show the disengagement of the sheet 1 from the split barge 100 according to the invention. In the presently illustrated embodiment the mounting element 5 comprises a magnet arranged on the edge 2 of the material free portion 3 of the sheet.

After the split barge 100 has been opened and the sheet 1 and the bulk of material (not shown) sinks towards the seabed the sheet may as in the presently illustrated embodiment be dragged along the inside surface of the

split barge, see Fig. 1, disengaging the mounting element 5 when the sheet is fully outstretched.

The mounting element 5 may engage directly with the split barge 100 or with a corresponding mounting element 105 arranged on the split barge or on the support element 102.

Fig. 4 schematically shows the use of different embodiments for sealing the sheet 1 according to the invention.

The sheet may comprise a mechanical sealing 10 or a chemical sealing in at least the self-closing portion 22 of the sheet. In the presently illustrated embodiment it is shown how the sheet can comprise a hook and loop fastener 11 and/or a mushroom fastener 12 on the inside surface 103 of the sheet.

Fig. 5 schematically shows the sheet 1 according to the invention comprising an outer sheet 1a wherein the sheet 1 constitutes an inner sheet 1b. In the presently illustrated embodiment the outer sheet and the material containing portion 4 of the inner sheet are arranged along the inside surface 103 of the split barge 100 and the material free portion 3 of the inner sheet is hold by a support element (not shown) along the outside surface 104 of the split barge. The material free portion 3 may be zig-zag folded. Alternatively the outer sheet and/or the inner sheet may be arranged along the outside surface of the split barge. One or more wires 30 (illustrated by the stippled line) are attached to the split barge in one end and the outer sheet in the other end.

The self-closing concept works as described above with the addition of that when the split barge 100 is opened and the weight of the bulk of material 101 pushes the outer sheet 1a and the inner sheet 1b into the water, the wire(s) 30 is tightened, causing the inner sheet to slide off the outer sheet. The inner

sheet continues sinking towards the sea bed while the outer sheet will be hanging in the wire(s) until outer sheet is pulled back up onto the split barge. As the inner sheet 1b and bulk of material 101 sinks towards the seabed the water pressure around the sheet encapsulates the bulk of material forming an encapsulated body (not shown) and collects the material free portion 3 into a tale following the sinking encapsulated bulk of material.

CLAIMS

1. A sheet (1) being placeable in relation to a split barge (100) and configured for encapsulating a bulk of material (101) to be dumped when the bulk of material (101) is released, the sheet (1) comprising a material containing portion (4) and at least one material free portion (3) extending from at least two opposed sides of the material containing portion (4), **characterized in** that the immersed sheet (1) encapsulates the bulk of material and comprises an encapsulated body (20) encapsulated by the material containing portion (4) and a self-closing portion (22) being at least a part of the material free portion (3) both extending from an assembly point (21), wherein a closing length of the self-closing portion (22) correspond to at least 5% of the circumventing length of the encapsulated body (20), the circumventing length extending from the assembly point (21) to the assembly point (21).

2. A sheet according to claim 1, **characterized in** that the sheet (1) further comprises at least on mechanical sealing and/or at least one chemical sealing.

3. A sheet according to claims 1 or 2, **characterized in** that the at least one mechanical sealing comprises a hook and loop fastener (11) or a mushroom fastener (12).

4. A sheet according to claims 2 or 3, **characterized in** that the at least one chemical sealing comprises an adhesive.

5. A sheet according to one or more of the preceding claims, **characterized in** that the sheet (1) further comprises at least one mounting element (5) for attaching the sheet (1) to the split barge (100) wherein the mounting

element (5) is configured for disengaging upon the weight of the sinking sheet (1) encapsulating the bulk of material (101).

6. A sheet according to claim 5, **characterized in** that the mounting element (5) comprises a strap and a snap-off element.

7. A sheet according to claim 6, **characterized in** that the snap-off element comprises a weak link along the strap configured for being broken.

8. A sheet according to claim 6, **characterized in** that the snap-off element comprises a snap-off button.

9. A sheet according to claim one or more of claims 2 to 5, **characterized in** that the mounting element (5) and/or the mechanical sealing comprises a magnet.

10. A sheet according to one or more of the preceding claims, **characterized in** that the sheet (1) is made of a degradable material.

11. A sheet according to one or more of the preceding claims, **characterized in** that the sheet (1) is made of a permanent material.

12. A sheet according to one or more of the preceding claims, **characterized in** that the self-closing portion (22) of the sheet (1) is made from a different material than the remaining sheet.

13. A sheet according to one or more of the preceding claims, **characterized in** that the sheet (1) comprises an outer sheet (1a) configured for being attached to the split barge (100) such that the sheet (1) constitutes an inner sheet (1b) configured for being in contact with the bulk of material (101).

14. A method of encapsulating a bulk of material (101) by means of a sheet (1) according to one or more of claims 1 to 12, the method comprising;
- arranging the sheet (1) in or under the split barge (100),
- filling the sheet (1) or the split barge (100) with the bulk of material (101),
- opening the split barge (100) so that the weight of the bulk of material (101) starts sinking the sheet (1) towards the seabed,
characterised in that the method comprises the step of encapsulating the bulk of material (101) followed by leading the sheet (1) into an assembly point (21) by means of a water pressure induced around the sinking sheet (1) and engaging the self-closing of the self-closing portion (22).

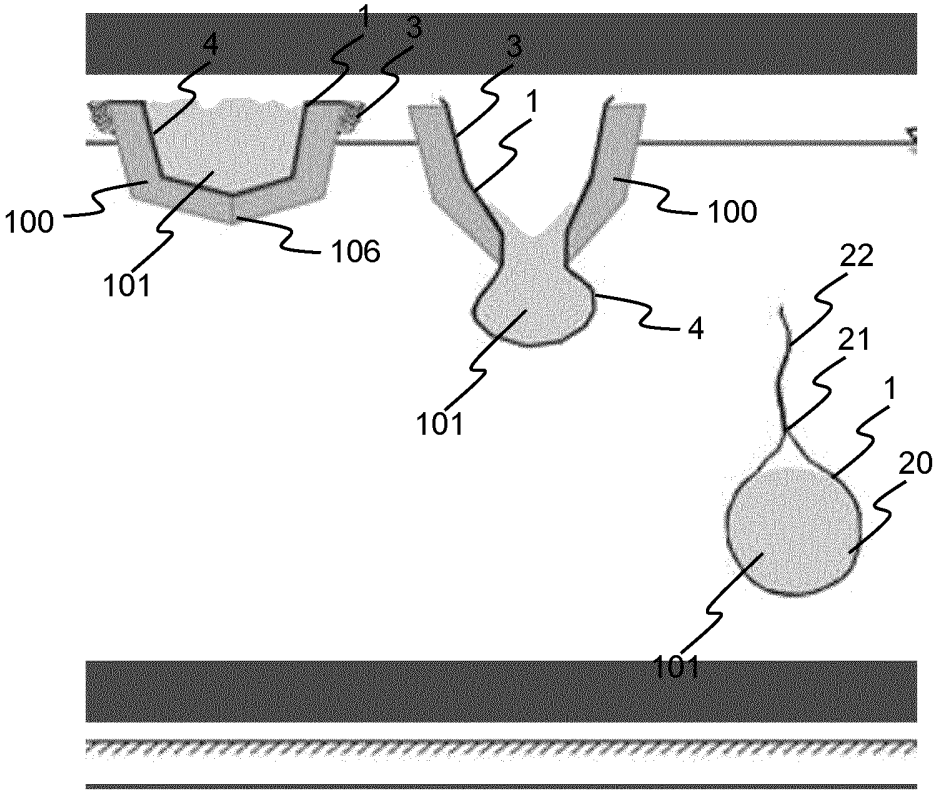
15. A method according to claim 14, wherein the sheet (1) comprises the mechanical and/or chemical sealing, **characterized in** that the method further comprises engaging the mechanical and/or chemical sealing concurrently with engaging the self-closing of the self-closing portion (22).

16. A method according to claim 14 or 15 wherein the sheet (1) comprises the outer sheet (1a) such that the sheet (1) constitutes an inner sheet (1b), **characterized in** that the method further comprises retrieving the outer sheet (1a) to the split barge (100).

17. A method of encapsulating a bulk of material (101) by means of a sheet (1) according to one or more of claims 2 to 12, the method comprising;
- arranging the sheet (1) in the split barge (100),
- filling the sheet (1) with the bulk of material (101),
- encapsulating the bulk of material (101),
- engaging the mechanical and/or chemical sealing, and

- opening the split barge (100) releasing the encapsulated bulk of material (101) which sinks towards the seabed.

18. A method according to claim 17 wherein the sheet (1) comprises the outer sheet (1a) such that the sheet (1) constitutes an inner sheet (1b), **characterized in** that the method further comprises retracting the outer sheet (1a) onboard the split barge (100).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4
3
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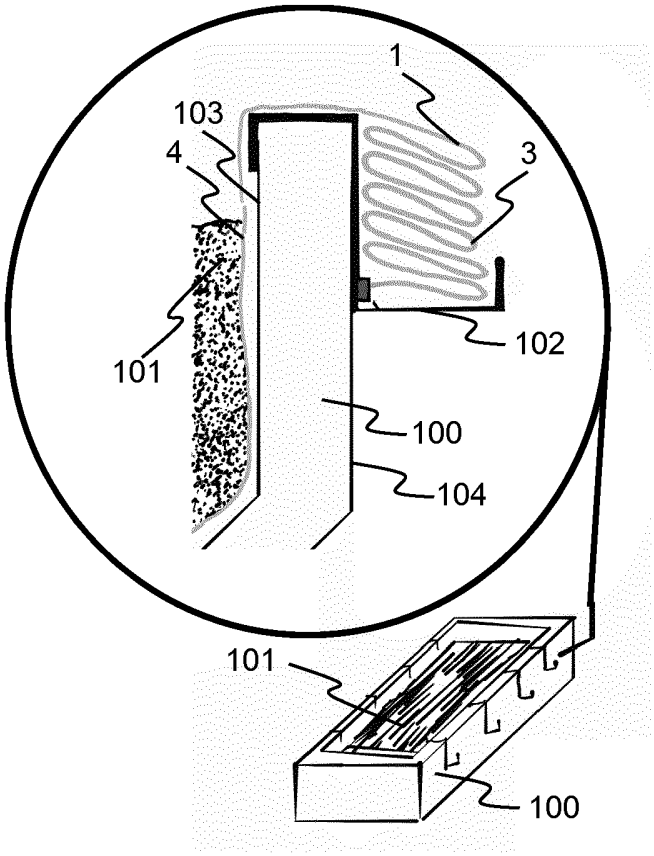
20
101

Fig. 1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3
101
102
100
104
101
100

Fig. 2

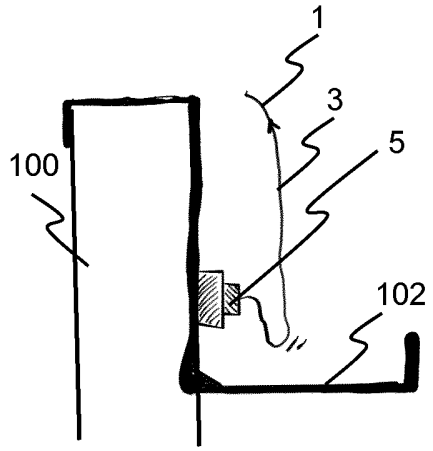

Fig. 3A

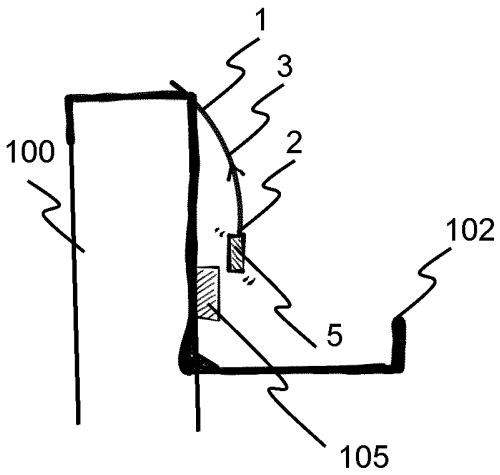

Fig. 3B

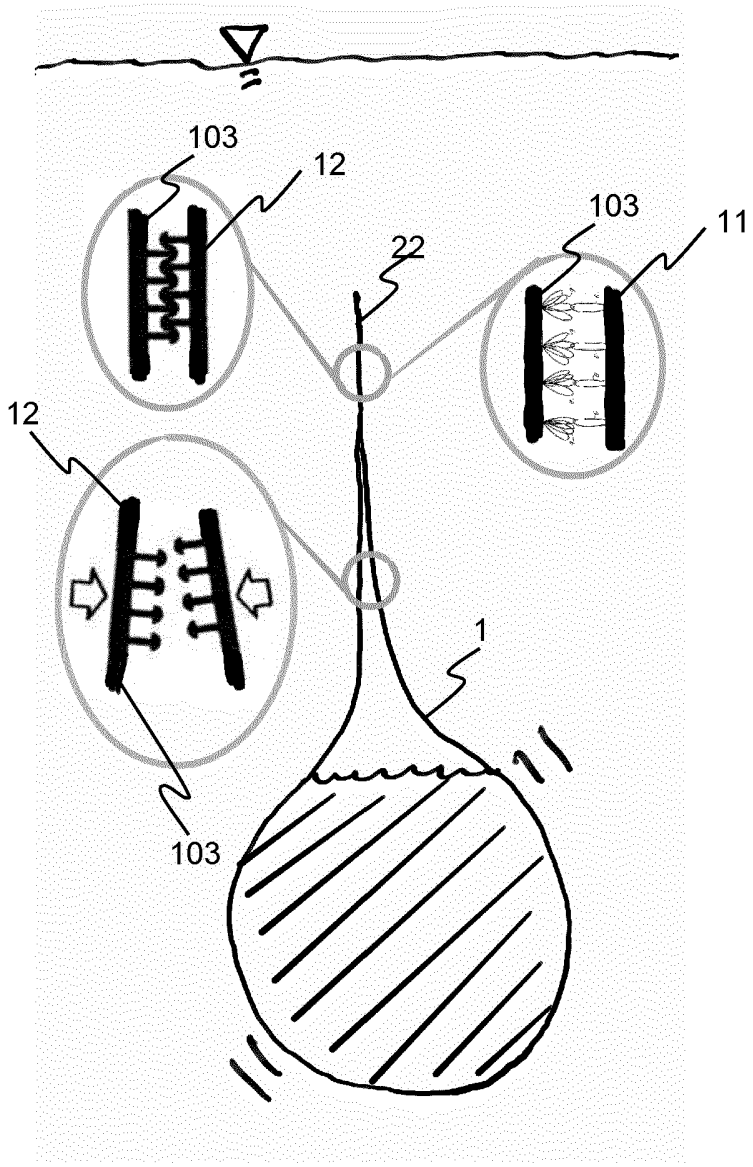

Fig. 4

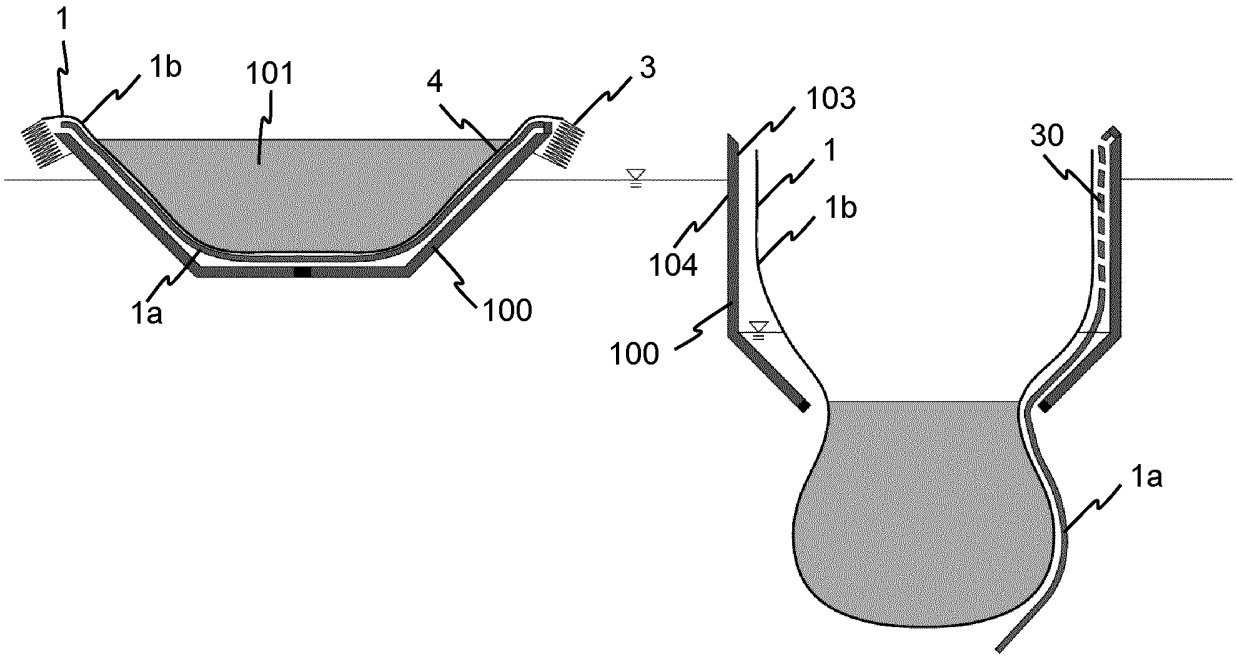

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/066414

A. CLASSIFICATION OF SUBJECT MATTER
INV. B63B35/30 B65D33/24 E02F7/04 E02F7/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E02B B63B B65D E02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	figure 1 figure 1 to 5 column 3, line 29 - line 47 column 1, line 11 - line 13 column 2, line 43 - column 3, line 3	1-13,18

X	WO 97/29247 A1 (TEN CATE NICOLON B V [NL]; KEMPERS ANTON DANIEL [NL]) 14 August 1997 (1997-08-14)	17
Y	figure 1 to 5	4
A	page 5, line 1.	1-3, 5-16,18

Y	JP H07 82722 A (PENTA OCEAN CONSTRUCTION) 28 March 1995 (1995-03-28) figure 1	1-13,17

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 September 2016	29/09/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bultot, Coralie

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/066414

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	figure 1 to 8 column 4, line 30 - column 6, line 22	5-8

Y	US 2011/005636 A1 (HARTLEY III JOSEPH W [US]) 13 January 2011 (2011-01-13)	1,5-11, 13
A	figure 1 to 8 paragraph [0022]	2-4,12

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A	figure 1 to 3	18

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A	figure 1 to 7	18

A	GB 1 554 298 A (BOS KALIS WESTMINSTER [NL]) 17 October 1979 (1979-10-17) figures 4-7	14

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